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RESETTING INSECTS' BIOLOGICAL CLOCK
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No Measuring, No Mixing, No Spraying

Springtime, 2000. Mr. Typical Home Gardener reads on his TV living room wall that it's time to control the spider mites that are poised, ready to attack his prize roses.

No problem. No measuring, no mixing, no spraying. Typical Home Gardener simply punches a button on his "chores" console, and a low density light bathes his garden. This special kind of light burns with an intensity and for a duration that wrecks the biological clock of spider mites; in this case, tricks them into thinking that the normal springtime 12 hours of daylight have suddenly been lengthened. Emerging prematurely, they die because the rose plants cannot sustain them this early in the year.

Another Century 21 flight of fancy? Perhaps. But the fact is that ARS scientists are now learning to use light in this manner against man's insect enemies. Insects are revealing much information about their responses to light.

At Beltsville, Md., a biochemist has caused tobacco budworms to enter a resting stage called diapause, and made codling moths break diapause through manipulation of daylength with light (page 8).

In other tests at the ARS Stored-Products Insects Laboratory, Savannah, Ga., scientists exposed Indianmeal moths to constant light. These pests showed a drop in egg-laying, probably because they prefer to mate in the dark.

Scientists have employed a flash of light during darkness, to upset insects' biological clocks (AGR. RES., July 1964, page 3). Some insects respond to different colored lights. Others need only exposure to low-density light to upset their biological timing.

The pathfinding research continues. Scientists have already learned that insects are sensitive to light through areas of the body other than the eye—a breakthrough because insects burrowed in cracks might not be able to hide from penetrating light.

Scientists may someday "arrange" the egg laying of insects. If the eggs were laid all at once, it would cut the costs of conventional control methods because a single insecticide application would eliminate the pests.

The day is coming when "turning on the light" will be commonplace in granaries—and perhaps home gardens. The act will receive no more thought than does throwing the switch to turn on the kitchen light.

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Conifer, Taiwania *in experimental forest near Chi-to (left). Branch and seed cone of conifer*, Ketelleria, *one of the many conifer collections made by Creech during his recent explorations (above photo) (PN–1619, PN–1620).*

PLANT EXPLORER COLLECTS NEW EXOTICS IN

Taiwan

SOME 150 exotic ornamentals—including rare rhododendrons and graceful conifers—were brought back from a recent plant exploration trip to Taiwan.

Taiwan is rich in woody ornamentals, and the plants collected by ARS plant explorer J. L. Creech should provide new and better adapted ornamentals for this country.

Creech's 6-week trip last fall was the 11th sponsored jointly by ARS and the Longwood Foundation, Inc., Kennett Square, Pa., and the first to Taiwan since 1918. These trips are designed to improve the quality and adaptation of our ornamentals by introducing improved germ plasm. Seven of the 11 trips were to Asia, reflecting how much that continent's beauty touches American gardens, streets, and landscapes.

Many of the early plant explorations were made in China; in recent times plant-hunters have had to work nearby countries with similar flora. Fortunately, Taiwan's wide range of ornamentals probably rivals those of mainland China or Japan.

Although Taiwan lies in the tropics, it has the highest mountains in the Far East except for the Himalayas. Elevations over 10,000 feet are common, and the highest peak, Mount Morrison, rises to 13,100. Plants growing at these altitudes should have the hardiness needed for U.S. climates.

Creech divided his trip into two parts, retracing the route taken in 1918 by the early plant explorer E. H. Wilson. Creech first hiked to the top of Mount Morrison, collecting seeds and plants along the way. Like Wilson almost 50 years before, he started up Morrison in early winter and, like him, was delayed by an unseasonal typhoon.

Near the peak of Mount Morrison, Creech collected two species of very compact rhododendrons, *Rhododendron pseudochrysanthum* and *R. morii*, long sought by U.S. breeders. The first one has white flowers, the other, white flowers with purplish spots.

The second part of Creech's trip was by jeep over a new east-west highway. This road, completed only 2 years earlier, opened up rugged territory previously untapped by plant collectors. Azaleas, rhododendrons, camellias, broadleafed evergreen oaks, and conifers flourished along the route, and Creech collected many of each.

One of the conifers, *Taiwania*, was collected in an experimental forest. This handsome evergreen with drooping foliage, is related to the cypress, and is not commercially available in the United States. It is becoming rare as a wild tree in Taiwan. Creech collected seedlings for botanical gardens as well as seed to raise plants for distribution to experiment stations and cooperating breeders.

Of the firs collected, *Abies kawakami* looks promising as a Christmas tree. It has attractive foliage and presents a well-shaped pyramid in silhouette.

Creech also brought back wild Chinese gooseberry cuttings taken at elevations over 10,000 feet. These cuttings may prove valuable to ARS plant breeders at Chico, Calif., who are trying to establish the Chinese gooseberry as a new crop for that State.■

Front view of mechanical aid, showing two of four pickers in position. Extensions in front pick up empty boxes, spaced along center of row beforehand (PN–1621).

Fruit Pickers Receive Assist from MACHINE

RELIEF MAY BE in sight for fruit growers faced with rising labor costs and shortages during harvest.

Agricultural engineers have built the prototype of a mechanical aid that, with changes in orchard design, can assist in harvesting nearly all the crop destined for the fresh fruit market.

The self-propelled machine handles many jobs previously done by pickers except for actually selecting fruit and pulling it from the tree. No mechanical device has yet been developed that can duplicate the human sensory capacity and dexterity needed.

The mechanical aid has been tested on apples, but can work for peaches, pears, and plums. Pickers riding the machine can harvest five times as much fruit as pickers with conventional equipment.

Four pickers, one sitting and one standing on each side of the mechanical aid, select and pull the ripe fruit and place it between twin conveyor belts which carry it to a bin. The belts are padded with foam rubber and grip the fruit gently but firmly.

When the bin is full, it is gently placed on the ground and an empty one takes its place. A picker who doubles as operator pushes the switches to do this.

While the bins are being switched, the mechanical aid stops. It automatically starts again when the empty bin is in place. Except for turning at the end of a row of trees, it steers itself, leaving the four pickers free to select and pull the fruit.

The machine was developed by agricultural engineers A. G. Berlage and G. E. Yost, of ARS, and experimental aide J. G. Marker, of Washington State University. They first tested the four-picker prototype at the Tree Fruit Research Center at Wenatchee in the 1967 apple harvest.

A two-picker unit was tested in 1965 to determine whether the idea was feasible.

Development of mechanical harvesting equipment is a must, not only for growers of tree fruit for fresh market, but for the entire tree fruit industry. Rising labor costs and shortages are forcing fruit growers to increase operational efficiency. In Washington, for example, about 900 workers are hired each year for every one million bushels of tree fruits harvested—23,000 for a 25 million bushel crop.

By 1980, conventional production in Washington will be an estimated 100 million bushels yearly, requiring about 92,000 workers, of which 80,000 would have to be imported and housed; the cost for only a few weeks would be prohibitive. Other fruit growing States have the same problems.

Berlage says that the tree fruit industry will eventually be automated. For the present, the mechanical aid can lower operating costs by reducing the number of workers.

The mechanical aid will be of immense value to the fresh-fruit market industry when operational. Berlage adds, however, that it must provide maximum efficiency—getting as much fruit per acre as possible without sacrificing quality. This would require changing the size and shape of conventional trees, as well as management practices.

Tree width should be no more than 6 feet from side to side, and tree height should be controlled by pruning or using smaller tree varieties. Each tree should touch the adjacent one in the row, providing a continuous wall. Orchard floors should be as level as possible, and tree rows should be about 8 to 9 feet apart and long enough to reduce frequent turns.

Because picker stations are fixed and each worker gathers fruit in a zone 3 to 4 feet high and 2½ to 3 feet into the center of the tree, the fruit should be no deeper than the picker can reach.

The researchers say a trend to smaller, more compact trees has already begun. ■

CHICKEN TEMPERATURE . . . by RADIO

TAKE A CHICKEN'S temperature with a radio? Such an idea might have been laughed at a few decades ago. Today, it is a reality.

ARS researchers have adapted radio transmitters to measure body temperatures of chickens as young as 1 day old in studies of responses to environment.

Measuring such responses of animals and fowls is important to researchers who must determine the effects of environment on performance.

The usual method is to wire recording equipment to sensors attached to the subject. Normally, animals or fowl must be restrained or anesthetized to keep them from tangling the wires. This procedure is undesirable because it may mask or distort the environmental effects that researchers are trying to measure. When measuring and transmitting data by radio, researchers need only to confine the birds in a pen or controlled-environment room.

In their studies, conducted at the South Central Poultry Research Laboratories, State College, Miss., agricultural engineer F. N. Reece and poultry husbandman J. W. Deaton adapted two transmitters, basing them on an existing design. Simple, inexpensive and easily assembled, each transmitter is about the size of a standard paper clip. One of the transmitters cost less than $5; the other about $7. Available equipment was costly and hard to use, and unsuitable for small animals and fowl.

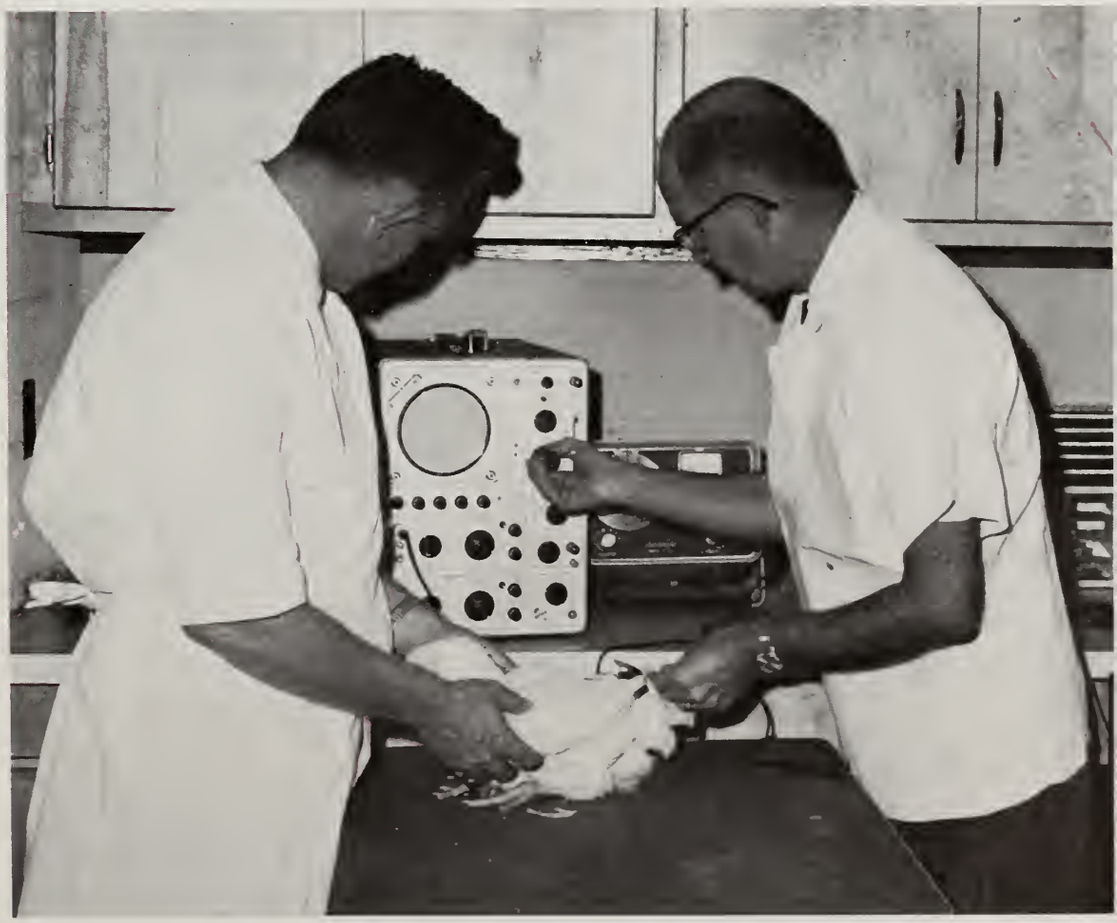
The devices are sensitive to warmth—or the lack of it—and react by sending out short bursts of energy that can be heard as "clicks" on any AM radio. The clicks come faster as temperature rises, slower as temperature falls.

Before transmitters are attached to the subject, they must be calibrated by exposing them to known temperatures and recording the rate of clicks for temperatures within the desired range. Clicks are checked by stopwatch.

In their studies Reece and Deaton connected the AM receiver to an oscillograph (energy recorder) equipped with a time marker. By counting the bursts of energy recorded on the oscillograph's chart, the marker determined the clicking rate. The scientists then converted the clicking rate to temperature by referring to the calibration curve established for the particular transmitter.

The transmitters only required calibration within a week of use to achieve a level of accuracy that was within plus or minus one half of one degree. The transmitters measured temperatures within a range of 15° to 45° C.■

Deaton, left, and Reece, check oscillograph to see if transmitter is functioning properly (PN–1622).



(BN-31424)

Why not an Egg a day... without a Break?

WHY DOESN'T A CHICKEN keep laying an egg a day, even though she has the capacity to do so?

The answer, ARS physiologists believe, lies in a timing mechanism in the hen's brain which governs the release of the yolk from the ovary.

As an egg starts down the assembly line, the ovary sends a hormone "ready" signal into the bloodstream. The signal is picked up by unidentified time-sensitive cells in the brain. The timing cells, in turn, send a startup signal down a nerve path into the hypothalamus, a gland near the base of the brain.

The hypothalamus transmits the message by sending a hormone to the anterior pituitary gland. This gland forwards the message to the ovary by releasing its own hormone, probably luteinizing hormone.

Egg production, from ovulation to lay, takes about 24 hours. Startup of a new egg would automatically occur about the same time every day, except that the brain's timing cells do not pass on the startup signal unless they have received the proper light stimulus. And even with proper light stimulus, the timing cells always take a while before reacting to the ovary's ready signal.

Good layers produce an egg per day for 2 or more days in a production series. Ovulation of the first egg in a series starts about the time that the lights go on in the laying house, say 6 a.m. Following release of the pituitary signal for the first ovulation, the ovary starts sending the ready signal for the second ovulation. Because the message is delayed by the signaling system, the ovary doesn't start the second ovulation until 26 hours and 47 minutes after the previous ovulation—the average time recorded in ARS trials.

Ovulation thus occurs at a progressively later hour as the production series lengthens. Startup time would be 8:47 a.m. on the second day and 11:34 a.m. on the third day.

With luck, ovulation would occur 2:21 p.m. on the fourth day. The light stimulus on the timing cells in the brain appears to be effective for only 8 or 9 hours, however. After that, the sensitivity of the cells to the ovary's ready signal ends. As a result, cutoff time for starting new work could easily be 2 p.m., or 8 hours after startup time for the first egg in the series. No egg would be started on the fourth day, ending the production series.

The scientists manipulated lights to keep hens laying beyond their usual production series; this effort failed, despite the fact that the day-length regulates the startup signal. Even under continuous light. hens continued pretty much on their usual laying schedule—perhaps guided by an inner clock.

In their Beltsville, Md., laboratory, however, the ARS physiologists were able to bypass the timing mechanism in the brain and increase production. In recent trials, an extract of hypothalamus glands from dead chickens channeled into the pituitary gland of live chickens resulted in eggs being started off-schedule 73 percent of the time.

Studies are underway to identify the hypothalamus hormone released by the brain impulse. The researchers suspect that it is composed of peptides, simple proteins containing only a few amino acids. ■

Farmer Can Tell at a Glance

SAFE CORN STORAGE PERIODS

A QUICK GLANCE at a chart will enable farmers to tell how long they can safely store shelled corn, regardless of its temperature and moisture content.

Rapidly increasing use of picker-shellers in recent years has compounded problems farmers have with storing high-moisture corn. Field shelling is a major advancement in harvesting efficiency, but such corn often has a very high moisture content. It should be dried at once to preserve quality, but this is not always possible.

Farmers forced to store high-moisture corn rely to a large extent on judgment and experience to estimate how long it may be stored. More accurate predictions will be possible with the new chart.

ARS agricultural engineer R. A. Saul prepared the chart after computing the safe storage limits, using a "reference curve" and formula he developed. Held within these limits, corn loses some quality but keeps its market grade. If held longer, the loss in quality causes grade to be lowered.

Saul developed his reference curve and formula after several years of measuring how much carbon dioxide shelled corn produces at various moisture contents and temperatures. The amount of carbon dioxide that corn produces is an accurate indicator of the amount of dry matter it loses at the same time. Loss of dry matter is a major cause of deterioration in quality.

When good quality corn sustains a dry matter loss of just 1 percent, it is usually lowered to grade 5 or sample grade, the lowest official U.S. grain standard. Corn can lose no more than one half of 1 percent of its dry matter before its market grade is lowered; this occurs when slightly more than 7 grams of carbon dioxide is produced per kilogram of dry matter.

Saul emphasizes that the chart, while accurate, is only a guide because other factors, beginning with harvest, influence storage life of corn. If there are delays, part of the storage time is used up before the corn gets to the storage area. In Saul's studies, the corn was brought to the storage area quickly and aerated at once to maintain temperature. Rodents and insects also reduce storage life and should always be controlled.■

Storage Air Temperature (fahrenheit)	CORN MOISTURE CONTENT 15%	20%	25%	30%
75°	116.0	12.1	4.3	2.6
70°	155.0	16.1	5.8	3.5
65°	207.0	21.5	7.8	4.6
60°	259.0	27.0	9.6	5.8
55°	337.0	35.0	12.5	7.5
50°	466.0	48.0	17.0	10.0
45°	725.0	75.0	27.0	16.0
40°	906.0	94.0	34.0	20.0
35°	1,140.0	118.0	42.0	25.0
	DAYS	DAYS	DAYS	DAYS

(PN–1623)

** Storage times given are those beyond which loss in corn quality will bring about a lowering of grade. It should not be inferred that corn held within these limits will suffer no loss in quality.*

ARS biochemist D. K. Hayes adjusting equipment developed by K. H. Norris of the ARS Instrumentation Laboratory, Beltsville, Md., for use in tests to determine how insects are affected by light of different intensities. Spotlight is beamed through window of compartment in background, which contains over one hundred insect pupae in "pigeon holes" seen through window (PN–1624).

LIGHT CAN RE-SET INSECTS' BIOLOGICAL CLOCK

SCIENTISTS ARE manipulating daylength to reset the biological clocks of insects. The studies may lead to new ways to control insect pests by throwing them badly out of step with nature.

Insect life cycles are attuned to daylengths at various seasons of the year. Some insects emerge from a resting state called diapause, for example, when their biological clocks respond to lengthening days of spring. In laboratory tests, insects have been deceived into breaking diapause by the right amount of artificial light.

If destructive insects respond similarly in the field, they could be tricked into breaking diapause and entering hostile environments where they would die from cold weather

or lack of food, or could not reproduce because of a lack of host plants. Damage would also be reduced by forcing insects into diapause when they would normally be ravaging crops (AGR. RES., July 1964, p. 3).

In studies at Beltsville, Md., ARS biochemist D. K. Hayes induced diapause in several insects. Resting codling moths, for example, came out of diapause when exposed to 16 hours of white or colored light and 8 hours of darkness. Very low intensities of blue light proved effective against this species.

Biochemist Hayes also found that tobacco budworms "went to sleep" when exposed to 8 or 10 hours of light and 16 or 14 hours of darkness. Pink bollworms diapaused when held in 8 hours of light and 16 hours of darkness. And she "stopped the clock" for European corn borers by providing 12 hours each of light and darkness.

In related tests at the ARS Stored-Product Insects Laboratory, Savannah, Ga., entomologist P. T. M. Lum exposed Indian-meal moths to constant light. This kept them from laying eggs for as long as 5 days, and reduced egg-laying by 75 percent. Delayed mating partly accounts for these results because the moth prefers to mate and lay eggs in darkness.

Manipulating light periods in storage facilities could theoretically force the moths to lay most of their eggs at a certain time. Control treatments applied at that time would wipe out most of the next generation of pests with less insecticide than normally needed. Practical applications of regulating light in storage facilities remain to be tested, however.

Insecticide requirements might also be minimized for certain household insects by taking advantage of their biological clock. Tests at Beltsville by entomologist W. N. Sullivan indicate that responses of cockroaches and house flies to light make these pests most vulnerable to treatment at about 4 p.m. (AGR. RES., May 1967, p. 10).

Chemists M. S. Schechter and Hayes are also studying the effects of light on corn earworms, butterflies and moths. In tests with oak silkworm pupae, they found that the eye isn't the only light-sensitive organ. The brain responds to light entering an adjacent "window" in the pupa.

Other tissue or materials in insects' bodies may also respond to light, and these responses may help scientists determine how bright a light should be, how long it must shine, and which colors are most effective. These processes may suggest other ways to trigger or stop insect diapause—including use of nontoxic, naturally occurring chemicals, combining various temperature and humidity conditions with controlled lighting, or even making better use of existing control methods. ■

AROMATIC OIL-WATER EMULSIONS GIVE CHEAPER WEED CONTROL

EMULSIONS OF AROMATIC oils and water provided excellent control of weeds in experimental plots of cotton—at only 40 to 60 percent of the cost of conventional herbicidal naphtha.

Two years of field and greenhouse research also show that emulsions of these benezene-derived oils work in cotton that is too old to treat with naphtha. They can be used after the formation of bark and on up to the blooming stage, or until the plant is about 10 weeks old. Naphthas are ineffective after the formation of bark, or beyond 3 to 5 weeks.

ARS plant physiologist E. L. Robinson conducted the experiments in cooperation with the Mississippi Agricultural Experiment Station at Stoneville. Robinson believes that another advantage of oils over naphthas is greater herbicidal selectivity. This would be another advance toward the goal of tailormaking herbicides to do specific jobs, to kill specific weeds while leaving other plants unharmed.

One difference between these oils and naphthas is their distillation range. Naphtha boils off at 300° to 400° F., while the oils boil off at 700° F. The oils have an aromatic content of 35 to 74 percent. To bring the aromatic content down to a level comparable with naphtha, Robinson dilutes the oils with water and an emulsifier. His most promising dilution reduced the final aromatic content to about 17 to 18 percent. Naphthas currently used for weed control in cotton generally have an aromatic content of 12 to 24 percent. ■

Dimick observing a gas chromatograph scan of flavor compounds (PN–1625).

How does a cow produce MILK FLAVOR PRECURSORS?

As secreted by the cow, milk is virtually without a definable flavor. But it contains many flavor precursors—compounds which are readily converted to other compounds with distinctive flavors when the milk is heated or exposed to the air or just allowed to stand around for a while.

Two groups of these compounds that can appreciably alter the flavor of milk fat are known as methyl ketones and lactones. Their precursors are being studied by scientists at the Pennsylvania State University under an ARS research grant.

Dr. Paul Dimick and his Penn State associates are studying the mechanism by which cows produce these precursors. They found that irregular fatty acids synthesized in the cow's udder are sources of the methyl ketones and lactones.

Like normal fatty acids, these irregular ones become attached to glycerol molecules to form glycerides, or fats. If later separated from their parent glycerol by heat—as in making milk powder—the irregular free fatty acids are quickly converted to methyl ketones and lactones. Since no air is required for their formation, the flavors they produce are called nonoxidative.

Methyl ketones and lactones are potent flavor compounds. Even a few parts per million will cause stale and other objectionable off-flavors in reconstituted beverage milk. In other dairy products, they are highly desirable. They impart the taste appeal of butter and cheese, and the lactones are used commercially to give a buttery flavor to margarine.

Heating fresh milk fat along with a minute amount of water liberates a class of compounds known as monocarbonyls, consisting mainly of methyl ketones. Steam distilling the fat similarly strips it of its lactones. By these methods the scientists established the flavor potential of milk fat.

They studied milk fat produced by their experimental herd for a year to see how both flavor precursors were affected by such variables as season, diet, stage of lactation, and breed of cow. The flavor precursors were more prevalent when the cows were fed in the barn than when held on pasture.

To another experiment, the methyl ketone and lactone potential of the milk fat from a single Holstein cow was followed over a 310-day lactation period. The lactone potential was quite low at first, rising dramatically to a maximum midway during the lactation. The short-chain fatty acids in the fat showed a corresponding trend: this is evidence that acetate, from which these fatty acids are derived, may be a source of the lactone precursors as well. This lactation study also showed a positive correlation between the lactone and methyl ketone potential of the milk fat.

Milk used in these experiments came from Holstein and Brown Swiss cows and from pooled samples of Jersey and Guernsey milk. Breed differences were not great, but milk fat from the Brown Swiss had somewhat less methyl ketone than the others, and that from the Holsteins yielded more lactone.

There was a negative correlation between the fat yield of the milk, and the lactone potential.

Cows suffering from ketosis had a sharp drop in the lactone potential of their butterfat. This is another indication of the role of acetate in the formation of milk flavor precursors. Ketotic animals are known to undergo a dynamic metabolic change which interferes with the synthesis of fatty acids from acetate.

This work is providing insights into how a cow actually makes milk fat and by what metabolic pathway the flavor precursors are formed. When this process is better understood, components important to flavor, such as methyl ketones and lactones, may be manipulated to the advantage of processors. On the other hand, it may well develop that the components are essential to milk fat synthesis, and that any effort to change their concentration or characteristics may substantially alter the properties of the milk.■

Saving Protein During Prolonged Storage

WHAT HAPPENS to the protein value of foods during storage can be important to consumers—especially in areas where getting enough protein in the diet is a problem.

To find some of the answers, scientists working under a Public Law 480 research grant at the Israel Institute of Technology, Technion, made the first systematic study of changes in protein nutrition value in selected foods under controlled storage conditions.

The Israeli scientists found that the protein nutrition value of certain foods changed over a 2-year period. In some of the foods, deterioration was progressive; that is, the protein depreciation never reached a plateau or leveled off. By and large, the storage conditions which increased loss of nutritive value and should be avoided are: prolonged storage, high temperature, and high humidity.

The researchers studied eight foods: defatted milk powder, cottonseed meal, peanut meal, soybean meal, wheat, rice, soybeans, and chickpeas. They took samples for chemical and biological measurements at 6-month intervals over the test period.

For the biological analyses, rats were used to measure protein metabolism efficiency which, it was found, steadily declined over the 2-year period.

Chemical measurements for protein in the foods included: three available forms of lysine, solubility of the proteins in different solutions, dyes that bind with proteins, and fluorescence.

Generally the protein nutritive value decreased less rapidly when the products were stored at 68° F. and 40 percent relative humidity than when stored at 86° or 104° and 60 percent relative humidity.

Of all the foods tested, defatted milk powder was the most sensitive to extreme changes in storage environment and showed a marked reduction in protein nutrition values. However, samples stored in cans containing less moisture than samples stored in bags generally had smaller losses in nutritive value—provided temperatures were comparable.

In all cases, except cottonseed meal, the products tested exhibited a decrease in protein efficiency as a result of extremes in one or more of the three storage conditions. The cottonseed meal exception may possibly be due to the high gossypol content of the meal used by the Israelis.■

U.S. SCIENTISTS HELPED BY

FOREIGN BEE RESEARCH

Scientist at one of the laboratories at the National Institute of Apiculture, Bologna, Italy. She is conducting laboratory analysis for Acarine disease (PN–1626).

SHOULD ACARINE DISEASE of honey bees invade North America, insect pathologists will make good use of Indian and Italian research findings obtained from two Public Law 480 grants.

Acarine disease, which is caused by the mite *Acarapis woodi*, cannot be studied here because of quarantine safeguards. The tiny mite pest, which is one hundredth the size of its host, invades the respiratory system of the adult honey bee where it reproduces and feeds, usually blackening the tracheal walls and causing death.

From original infestations in Europe, the disease has spread to parts of Africa, South America, and Asia. It is a potential threat to the U.S. honey bee industry, which produces about $50 million worth of honey and beeswax annually. Bees have an even more vital role; they pollinate U.S. crops valued at more than $1 billion.

In work at the Punjab Agriculture University, Ludhiana, investigators have established the presence of the acarine disease mite in the Indian honey bee, *Apis indica*. They also controlled the disease with the acaricide, Chlorobenzilate, and furnished valuable information on optimum dosage levels.

In other Indian experiments, the acarine mite was transmitted from diseased Indian honey bees to healthy American and European bees, *Apis mellifera*, proving that the disease can be spread between species. This could easily happen when a stronger colony robs a weaker one.

Italian scientists at the National Institute of Apiculture, Bologna, have also contributed to the knowledge of acarine disease. Formerly, it was thought that the mites fed and laid their eggs only in the honey bees' tracheae. However,

the Italians found mites distributed not only in the thoracic tracheae, but also in the air sacs of the thorax, head, and abdomen. This means that bees free of mites in the tracheae cannot necessarily be diagnosed acarine-disease free.

Italian scientists also proved that the acarine mite can live on the brood (larvae and pupae) of the honey bee. This new knowledge is significant for two reasons: it makes possible mass laboratory rearing of the mites for continuing study, and it demonstrates the possibility of spreading the disease to the United States by importation of brood stock. (U.S. beekeepers can import adult honey bees only from Canada.)

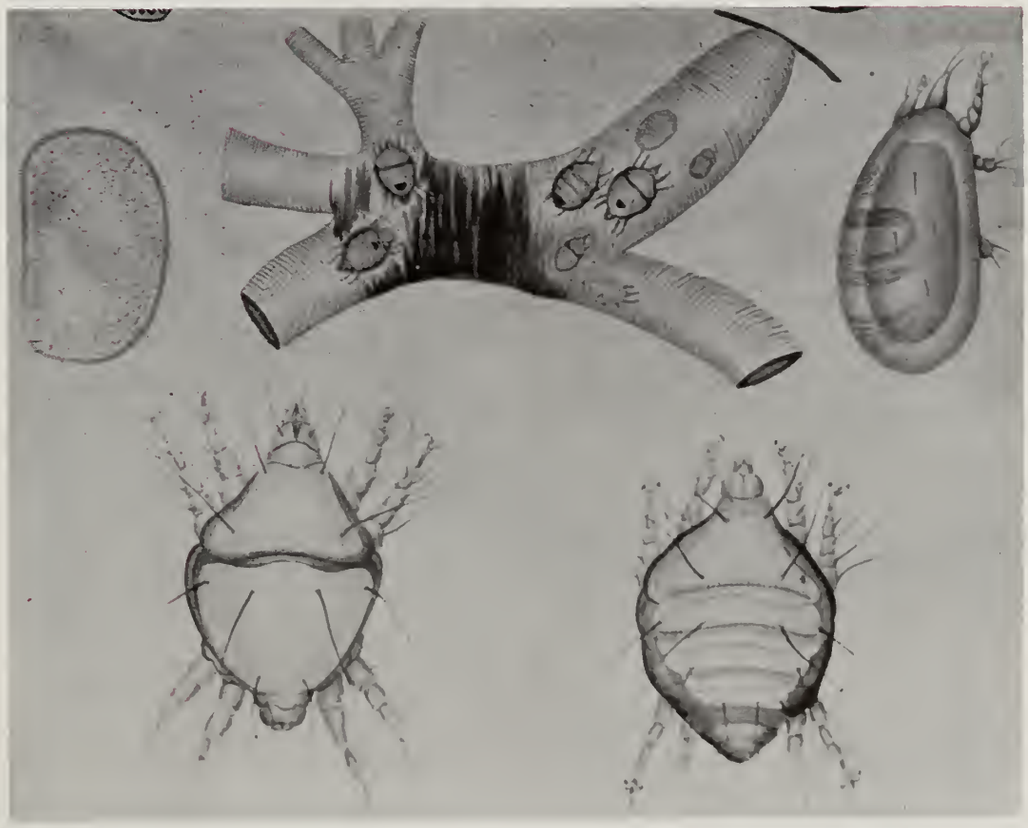
Other findings about the acarine mite and its host:

- Infestation increases in the winter and declines in the spring and summer making the warmer seasons a more propitious time for chemical treatment.
- Menthol shows great promise as an effective acaricide.
- Although the probabilities of infestation diminish as bees age, even old bees (10 days or more) are susceptible, particularly in winter.
- Under normal circumstances, mites survive their bee hosts by periods ranging from 15 hours to 8 days; this allows ample time to reinfest a new, living host.

The findings of both the Indian and Italian investigators have laid the groundwork for future research that may provide the answers to many problems as, for example, the possibility of breeding acarine-resistant bees.■

A slide ready for acarine disease analysis under the binocular, shows the cut pieces of bee thorax (PN-1627).

Acarapis woodi *Rennie, the agent of acarine disease. Adult male (lower left), and female (lower right), larva, egg, tracheal infestation (PN–1628).*



FUNGUS—RESISTANT SUGARBEETS . . .

developed, released to breeders

A TOUGH LITTLE FUNGUS that causes root and crown rot in sugarbeets may someday meet a tougher sugarbeet root.

ARS plant pathologist J. O. Gaskill has developed two breeding lines of sugarbeets with some resistance to the fungus *Rhizoctonia solani* and is now working to develop lines with even better resistance. Gaskill is conducting the research at the Colorado Agricultural Experiment Station, Fort Collins, in cooperation with the Station and the Beet Sugar Development Foundation.

Rhizoctonia rot is a serious problem in all major U.S. sugarbeet growing areas. The fungus is in most agricultural soils and is capable of persisting indefinitely. Crop rotation gives only limited protection. No chemical treatments of soil or seed are commercially practical, and no usable plant resistance was available in sugarbeets until now.

The resistant lines (FC 701 and FC 702) have been released to the sugarbeet industry. Although the lines are not suitable for commercial use, they do provide germ plasm for breeding resistant varieties.

In the new lines, resistance tends to increase with the age of the plants, which is fortunate because the greatest losses from the disease usually occur in midsummer or later in the growing season. Rhizoctonia comes in a wide range of races—and it is not known yet if the new lines will resist them all.

Gaskill developed the two resistant lines through mass selection from heterogeneous sugarbeet populations, a technique sometimes used when available lines and varieties show little or no resistance to a disease. Individual plants within lines or varieties may appear to be resistant and these are selected as a source of resistance.

In mass selection the scientist subjects a large number of plants to the disease, then selects and saves the ones that appear resistant. He uses these to produce progenies and puts them through the same selection process. Gaskill used 4 cycles of selection to produce the resistant lines.

Breeding for Rhizoctonia rot resistance is complicated by the highly erratic behavior of the fungus. In the field, it may cause little damage one year and severe damage the next. Gaskill had to use artificial techniques to uniformly expose the plants to the disease. Initially, he placed innoculum in the tap root or at varying distances and depths from the root.

Even artificial techniques sometimes do not work well. Inoculation killed most or all of the plants in some cases, and only a very few in others. After testing several methods for several years, Gaskill found the most effective was the "rosette method," in which inoculum is applied to the center of the foliar rosette (leaf cluster). When inoculation was made 3 to 5 weeks after thinning, this method gave the best results and was used extensively in developing the new resistant lines.■

EXOTIC CORN IS TALL — LOW IN PROTEIN

EXOTIC VARIETIES of corn from the tropics produce more silage per acre than domestic silage corn, but the low quality of the silage and the difficulty in machine handling will likely limit their use.

That's the conclusion from research trials conducted by ARS agronomist D. L. Thompson in cooperation with the North Carolina Agricultural Experiment Station, Raleigh.

The tropical varieties of corn grow very tall when moved to more northern latitudes. They appeared to be good sources of silage. To check this, Thompson compared silage production of three standard hybrids with nine exotics for 3 years at three locations.

In the trials the exotics yielded much more silage than the standard hybrids—13 to 41 percent more dry matter and 4 to 28 percent more estimated digestible nutrients. Silage quality as measured by crude protein content was much lower in the exotics, however.

Thompson points out that silage from the exotics would be satisfactory for feeding situations requiring low energy levels—overwintering beef cows, for example. The protein and energy level could also be improved by adding urea and corn grain at ensiling, or by supplementing the ration at feeding.

Harvesting difficulties, however, appear to be the main disadvantage with exotics at the present time. Current silage harvesting machinery would be slowed by the tall growth. The tall growth and late maturity of exotics would also increase the blowdown hazard. which further complicates harvesting.■

Two-Step Pruning

A new system involving drastic two-step pruning is helping renovate intensively managed coffee groves in Puerto Rico.

Increased coffee yield, better sucker growth, and less tree die-back make the new system superior to older methods.

Planters can keep intensively managed coffee trees in good condition for years by simply removing old, broken, and excess suckers. Eventually, however, growth becomes so thick and tangled that losses from berries dropping to the ground during picking may reach 30 percent of a 1-ton-per-acre crop.

ARS researchers felt dissatisfied with the current one-step solution, in which the entire tree is cut off 1 foot from the ground soon after picking. They noted that many of these trees die, sucker growth is often weak, and fungus attacks are common during the first year after stumping.

Finding little information on alternatives to drastic pruning methods, ARS, in cooperation with the University of Puerto Rico, experimented with an original two-step system. The first year, scientists cut back all but one vertical branch; the next year that branch bore a crop, then it was pruned.

Trees pruned with one vertical branch remaining produced an average of 732 pounds of market coffee per acre the first year. Trees pruned in one step bore no crop during that time. The second year, trees stumped by the two-step system yielded almost three times more market coffee than the others.

The new method also increased sucker growth by 40 percent and sharply reduced die-back, as measured 10 months after initial pruning.

In a separate experiment, the scientists found that stumping in March, after the trees had recovered from the strain of producing a crop, results in better total and monthly sucker growth than does pruning directly after harvesting as currently practiced.

The experiments were carried out on 10-year-old, intensively managed Bourban coffee trees growing close together in rows 10 feet apart in full sunlight, at an elevation of 2,500 feet.

Which Pallet Box?

Pallet boxes—bulk shipping containers—made from wire mesh cause less injury to shipped mature-green tomatoes than those made from several other materials. However, damage to ripe tomatoes is not reduced by any type of construction material.

ARS research analyst J. F. Herrick, Jr., Michigan State University agricultural engineers B. A. Stout and F. W. Bakker-Arkema, and horticulturist S. K. Ries tested ripe and mature-green tomatoes in wood, plastic, fiberboard, plywood, and wire mesh boxes.

The scientists say that important considerations in constructing pallet boxes are initial cost, life expectancy, and ease of cleaning.

Wire mesh boxes are strong, durable, and easy to clean, but initial cost is higher and they are subject to corrosion.

Wooden boxes are inexpensive and easy to build, but are hard to clean.

Plastic boxes are strong and easily cleaned, but are costly and difficult to construct.

Fiberboard boxes, while inexpensive lack durability and are difficult to clean.

Flies Are Becoming Immune

House flies are becoming resistant to some of our best insecticides in as little as 2 years. And because insecticides—as a supplement to sanitation—offer the fastest and easiest way to control houseflies, ARS entomologists at Gainesville, Fla., are testing hundreds of experimental compounds in a search for replacements for older insecticides.

A high reject rate characterizes tests on experimental fly killers. Many materials flunk out when they fail to kill at least 90 percent of the flies in preliminary screening. And only a fraction of those that survive preliminary tests pass the grade in the next round of tests. For example, in recent experiments by ARS entomologists H. G. Wilson, J. B. Gahan, and G. C. LaBrecque at Gainesville, only 10 of 168 compounds remained effective through the 24-week test period. Two other compounds lasted 20 weeks, and 31 were effective for 4 to 12 weeks. Over 100 lasted 1 week or less.

These are the results of laboratory tests. Still fewer materials will make the grade in field tests, and even fewer will meet the safety requirements.

AGRISEARCH NOTES

Nitralin May Help Breeders

Nitralin, a herbicide commonly used to control weeds in cotton and soybeans, may prove to be a valuable tool for developing new breeding lines and varieties of plants.

ARS plant physiologist W. A. Gentner and geneticist L. G. Burk investigated nitralin after noticing the stunting and swelling effect it had on corn roots. Their investigations at Beltsville, Md., show that nitralin prevents the formation of cell walls, and therefore cell division. Some cells become grossly enlarged and develop many nuclei. The scientists believe that nitralin causes chromosomes to duplicate themselves and, if this is so, nitralin may be useful to plant breeders.

Two other chemicals presently in use—colchicine and naphthaleneacetic acid—are currently used by plant breeders to achieve polyploidy, a condition in which a plant has more than the normal number of chromosomes. The polyploid condition can produce plants of unusual size or vigor. It also makes possible the crossing of plants that would otherwise be incompatible.

Gentner and Burk believe that nitralin may be a more effective agent than colchicine or naphthaleneacetic acid to stimulate chromosomal duplication, although more work must be done with the chemical to evaluate exactly what it does within a cell.

Steers Don't Dawdle

An electronic surveillance system used in ARS tests showed that when steers were near the feeder, they ate 94 to 97 percent of the time.

Knowledge about the time animals

actually spend eating is basic to studies on eating habits of cattle—studies which help determine feeder space needed per animals or proper lighting of feedlots.

The electronic system was installed by beef cattle nutritionst P. A. Putnam. When a steer comes to the feed bunk, he breaks an electric light beam, thereby activating a recorder attached to a time clock.

Feed consumption rate did not vary significantly in the 24 hour day. Time spent eating varied with the type of feed, however. Steers took half again as long to eat a ration of coarsely ground hay plus limited grain as one of pellcted hay and liberal grain.

Blueberry Harvester Ready

A mechanical blueberry harvester that does the work of 120 pickers in one day is now commercially available.

The over-the-row harvester reduces labor costs to less than 1 cent per pound of blueberries. It is the offspring of a prototype built by ARS engineers J. H. Levin and G. E. Monroe in cooperation with Michigan State University, East Lansing (AGR. RES., February 1964, p. 12).

The mechanical harvesting of blueberries not only reduces labor costs, but makes it possible to harvest tons of fruit that previously were left unpicked because pickers made only two harvests during the long growing season, moving on to other crops.

As the harvester moves over a row of blueberries, two upright, rotating spindles with vibrating "fingers" shake ripe berries free to drop into catching pans below. Only three men are needed to operate the picker.

CAUTION: In using pesticides discussed in this publication, follow directions and heed precautions on pesticide labels. Be particularly careful where there is danger to wildlife or possible contamination of water supplies.

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